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L21: Entry 6 of 13 File: USPT Mar 2, 1993

DOCUMENT-IDENTIFIER: US 5190357 A
TITLE: Air-actuated brake system for vehicles

Abstract Text (1):
The preferred embodiment of the invention is a brake system comprised of a primary source of air under pressure, and independent secondary source of air under pressure, a primary relay, a secondary relay valve, a device for actuating the service brakes, a device for actuating the park brakes and a control device, and a plurality of brake assemblies. The primary relay receives air under pressure only from the primary source and the secondary relay receives air under pressure only from the secondary source, but the other components are so arranges as to achieve complete system redundancy in operation at the source level, the brake level, the hose level, and at the actuation level.

Brief Summary Text (3):
This invention relates generally to an air-actuated brake system for vehicles and, more particularly, to improvements in such systems of the type which include separate primary and secondary sources of air under pressure that are so connected to brake assemblies as to apply either the service or park brakes even though air is lost from one of the sources.

Brief Summary Text (6):
The prior system found in U.S. Pat. No. 4,907,842 includes a control means, sometimes called a "multi-function" or "MF" valve, that delivers air received from each of the sources directly to the brake chambers of associated brake assemblies. Thus, although the system was redundant in the sense that the service and park functions were split at the brake level, the loss of a hose leading to the brake chambers resulted in the loss of all parking function unless the operator of the vehicle applied it through the service side. In the case of a spring brake in a system of this type, a lost hose leading to a service brake would result in loss of the service function, and loss of a hose leading to a park brake would cause the brake to be applied automatically.

Brief Summary Text (9):
The preferred embodiment of the invention is a brake system comprised of a primary source of air under pressure, and independent secondary source of air under pressure, a primary relay, a secondary relay, a means for actuating the service brakes, a means for actuating the park brakes, a control means, and a plurality of brake assemblies. The primary relay receives air under pressure only from the primary source and the secondary relay receives air under pressure only from the secondary source, but the other components are so arranged as to achieve complete system redundancy at the source level, the brake level, the hose level, and at the actuation level.

Brief Summary Text (10):
Because of the complete system redundancy, any one relay, source or any hose can be lost without losing either the service or the park brakes. For instance, if the delivery hose is off or the primary relay valve severed, it will only dump primary air and the secondary relay can still apply the parking and service brakes with full air through the secondary circuit. Conversely, if the secondary circuit's

delivery hose is broken, then it will only dump secondary air and air from the primary air source will be delivered through the primary relay to apply the parking and service brakes.

Drawing Description Text (4):
FIG. 2 is a view of another air actuated brake system constructed in accordance with the present invention and is similar to the system of FIG. 1 except that it further includes a third source of air under pressure dedicated for use with the park brake of the system;

Detailed Description Text (4):
Each of the brake assemblies 101-106 is mounted to an axle for applying the brakes of the respective assembly. Brake assemblies 101-104 provide brakes only in a service application, while brake assemblies 105-106 have both service and a park applications. Brake assemblies 105-106 receive air under pressure via a two-way check valve whereas brake assemblies 101-104 receive air under pressure directly from either quick release valve 90 or primary relay 70. Each one of brake assemblies 101-106, however, includes a brake pressure chamber having a diaphragm to which a rod is connected for applying the service brakes when air is supplied to the chamber against the diaphragm to move the rod outwardly with respect to the vehicle. Brake assemblies 105-106 include not only a pressure chamber having a diaphragm for applying the service brakes in response to a supply of pressure to the pressure chamber, but also a park brake.

Detailed Description Text (5):
The park brake in brake assemblies 105-106 comprises a piston with teeth on its lower end adapted to engage a rack on the rod to lock the brakes in a park position when the rod has been moved to the applied position. More particularly, the piston is urged downwardly into locking position by a spring, but upwardly in response to air supplied to the lower side of the piston and thereby constitutes a locking means for the brake assembly. Thus, upon venting of the air on the lower side of the piston, the spring urges the piston downwardly to lock the position.

Detailed Description Text (8):
Service actuator 40, sometimes known as a treadle valve, is actuable upon receipt of air from either one, or both, of primary air or secondary air to generate a signal indicating that service brakes either be applied or released that is transmitted to a first signal port of control means 60 via line 38, to the control port of primary relay 70 via lines 38 and 42, to the balance port of secondary relay 80 via line 44, and to quick release valve 90 via line 46.

Detailed Description Text (9):
Service actuator 40 operates in a manner well known to those in the art in that depressing the dual treadle allows two valves (not shown) contained therein to open, thereby allowing air under pressure to pass from lines 22 and 32 into lines 38, 44, and 46 transmitting a primary and a secondary signal, respectively, to control means 60, a primary and a secondary signal to primary relay 70 and secondary relay 80, respectively, and a secondary signal to quick release valve 90 indicating that the service brakes are to be applied. The primary signal is transmitted with primary air and indicates that the service brakes are to be applied with primary air. Similarly, the secondary signal is transmitted with secondary air and indicates that the service brakes are to be applied with secondary air.

Detailed Description Text (10):
Releasing the dual treadle closes the internal valves of service actuator 40 thereby closing lines 32 and 22 and exhausting lines 38, 44 and 46. Exhausting lines 38, 44 and 46 results in loss of signal to each of control means 60, primary relay 70, secondary relay 80 and quick release valve 90. Air under pressure in line 22 does not mingle with that of line 32 in service actuator 40 such that the

primary side and the secondary side remain isolated and that line 38 contains primary air and lines 44 and 46 contain secondary air when under pressure.

Detailed Description Text (11):
Park actuator 50 receives air under pressure from two-way check valve 30 via line 48 and transmits a signal to a second signal port of control means 60 via line 52 indicating whether the park brakes are to be applied or released. Two-way check valve 30 receives air under pressure from both primary source 10 and secondary source 20 and operates in a manner well known in the art to allow air from either line 18 or line 28 into line 48 such that the air under pressure in line 48 may originate from either primary source 10 or secondary source 20 while isolating the primary side of the system from the secondary side.

Detailed Description Text (12):
Park actuator 50 is typically a push-pull valve having an exhaust port and is actuable upon receipt of either one, or both, of primary air or secondary air. The supply port of park actuator 50 is opened thereby delivering air under pressure from line 48 to line 52 via the delivery port of park actuator 50 until such time as park actuator 50 is actuated. When park actuator 50 is actuated, its supply port is closed and line 52 is exhausted via the delivery and exhaust ports of park actuator 50, thereby transmitting a park signal to control means 60 indicating that the park brakes are to be applied. The exhaust port of park actuator 50 is closed and the supply port opened when park actuator 50 is deactuated thereby restoring air under pressure in line 52 and resulting in loss of signal to the second signal port of control means 60.

Detailed Description Text (15):
The operation of the brake system shown in FIG. 1 may be separately described in its service brake application and in its park brake applications. Application of service brakes involves supplying air under pressure to the pressure chambers of brake assemblies 101-106 via their associated lines and application of the park brakes necessitates exhausting air under pressure in lines 54 and 55 subsequent to delivery of air under pressure to the pressure chambers of brake assemblies 105-106.

Detailed Description Text (16):
Service brake application typically occurs when the brakes of all brake assemblies 101-106 are in a released state and, as such, lines 71-74, 81-82, and 91-92 have all been exhausted and contain only negligible amounts of air under pressure. Service brake application begins by depressing the treadle of service actuator 40 to allow air under pressure in lines 22 and 32 to enter lines 38 and 44 thereby generating and transmitting a signal to the first signal port of control means 60, the control port of primary relay 70, and the balance port of secondary relay 80. Receipt of the service signal by control means 60 prevent application of the park brakes (i.e., the locking means of brake assemblies 105-106) as is discussed below. Upon receipt of the service signal at their control and balance ports, respectively, primary relay 70 and secondary relay 80 deliver air under pressure from their respective supply to the brake chambers of their respective brake assemblies. Quick release valve 90 similarly delivers air under pressure to brake assemblies 101-102 via lines 91-92 upon receipt of the service signal via line 46.

Detailed Description Text (17):
Release of the treadle of service actuator 40 results in loss of service signal whereupon primary relay 70 and secondary relay 80 shut off delivery of air under pressure from supply and primary relay 70 exhausts the pressure from lines 71-74 and secondary relay 80 vents pressure from lines 81-82. Similarly, quick release valve 90 vents pressure from lines 91-92. Exhausting lines 71-74, 81-82, and 91-92 exhausts the pressure from the brake chambers of brake assemblies 101-106 and thereby releases the brakes of those assemblies.

Detailed Description Text (19):
Park brake application also typically occurs when the brakes of each of brake assemblies 101-106 are released, and as such, lines 71-74, 81-82, and 91-92 are exhausted while lines 52 and 54-55 are under pressure. When park actuator 50 is actuated, it shuts off air under pressure from supply and exhausts pressure in line 52 through its exhaust port, thereby signaling control valve 60 to apply the park brakes of assemblies 105-106. At the same time, the treadle of service actuator 40 must be in a released state since pressure on either one of line 38 or line 52 will prevent application of the park brakes. Control means 60 then delivers air under pressure from supply to primary relay 70 and secondary relay 80 to apply air to the pressure chamber of brake assemblies 103-106. Once the service brakes are applied, control means 60 exhausts lines 54-55 thereby activating the means for locking in assemblies 105-106 to complete the park brake application.

Detailed Description Text (20):
When park actuator 50 is deactuated, air under pressure from supply is delivered to the second signal port of control means 60 thereby restoring pressure to line 52. Pressure is then restored to line 54-55 to release the means for locking in assemblies 105-106 and lines 56 and 58 are then exhausted, causing loss of service signal to primary relay 70 and secondary relay 80 to exhaust the pressure in the brake chambers of 105-106 thereby releasing the service brakes and completing the release of the park brakes.

Detailed Description Text (24):
Redundancy is also attained in the park brake application of the brake system, although in a different manner. Air under pressure in line 48 may be obtained from any one of the two separate isolated sources of air pressure in the system, those being primary source 10 and secondary source 20. The park signal is transmitted directly and solely to control means 60 in contrast to the service side of the system wherein the service signal is transmitted in parallel and to multiple destinations. However, since exhaust of pressure in line 52 constitutes transmission of the park signal, a rupture in line 52 will be perceived as a signal to apply park brakes thereby achieving redundancy through a fail-safe mechanism.

Detailed Description Text (26):
Thus, the additional of park source 110 provides an additional level of redundancy to service brake application since the service side and the park side of the brake system are now supplied with air under pressure from three independent and isolated sources as opposed to two separate sources found in the brake system of FIG. 1. Further, control means 60a is supplied with air under pressure at its first supply port from park source 110 via line 118 and at its second supply port with air under pressure from either one of primary source 10a or secondary source 20a via two-way check valve 30a and line 126. Control means 60a in the embodiment of FIG. 2 may therefor be supplied with air under pressure from any two of three independent isolated sources for the purpose of applying the park brakes.

CLAIMS:

1. An air actuated brake system for a vehicle, comprising:

a brake assembly for at least one axle thereof including a service brake which is applied upon delivery of air thereto and a park brake which is applied upon the venting of air therefrom,

a primary source of air under pressure,

a secondary source of air under pressure separate from the first source,

a primary relay for receiving air from said primary source and delivering it to the service brake in response to at least one of a service signal and a parking brake,

a secondary relay for receiving air from said secondary source and delivering it to the service brake in response to at least one of a service signal and a parking signal,

control means adapted for receiving air from at least one of said primary and secondary sources and adapted, in response to a park signal to vent air from the park brake and to transmit a service signal to primary and secondary relays, respectively,

means actuable, upon the receipt of air from at least one of said primary and secondary sources, to transmit a service signal to said primary and secondary relays, respectively, and to said control means,

means actuable, upon the receipt of air from at least one of said primary and secondary sources, to transmit a park signal to the control means, and

means for preventing loss of air delivered to the service brake or the control means in the event of loss of air from either source.

9. An air actuated brake system for a vehicle, comprising:

a brake assembly for at least one axle thereof including a service brake which is applied upon delivery of air thereto and a park brake which is applied upon the venting of air therefrom,

a primary source of air under pressure,

a secondary source of air under pressure separate from the first source,

a primary relay for receiving air from said primary source and delivering it to the service brake in response to at least one of a service signal and a parking brake,

a secondary relay for receiving air from said secondary source and delivering it to the service brake in response to at least one of a service signal and a parking signal,

control means adapted for receiving air from at least one of said primary and secondary sources and adapted, in response to a park signal to vent air from the park brake and to transmit a service signal to primary and secondary relays, respectively,

means actuable, upon the receipt of air under pressure, to transmit a service signal to said primary and secondary relays, respectively, and to said control means,

means actuable, upon the receipt of air under pressure, to transmit a park signal to the control means, and

means for preventing loss of air delivered to the service brake or the control means in the event of loss of air from either source.

L15: Entry 4 of 5 File: USPT Mar 25, 1997

DOCUMENT-IDENTIFIER: US 5613744 A
TITLE: Incipient brake fade detection for traction control systems

Abstract Text (1):
A motor vehicle brake control system having traction control and incorporating controller features and methods of operation which interrupt activation of the traction control system in conditions likely to develop excessive brake temperatures, exceed available brake pressure limitations, or other adverse brake conditions. This feature is provided by monitoring the behavior of the system, and based on known braking system characteristics, disabling the traction control when certain parameters are exceeded. The system provides these features without the need to directly measure brake temperature, brake system pressure or other physical parameters.

Brief Summary Text (2):
This invention is related to motor vehicle brake control systems and particularly to an improved traction control system incorporating features to reduce the likelihood of developing adverse brake conditions through operation of traction control.

Brief Summary Text (3):
Many motor vehicles today incorporate traction control systems. These systems enhance the directional stability of a vehicle and the total traction availability in conditions where one or more of the drive wheels encounters a low coefficient of friction surface or otherwise develops a wheel spinning condition. The tractive effort available from the spinning wheel is decreased due to the spinning condition. Moreover, most motor vehicles incorporate a differential in which torque applied to the non-spinning wheel on one side of the vehicle is reduced when the drive wheel on the other side encounters a spinning condition. Therefore, total tractive effort is reduced. With traction control, the speeds of the drive wheels are detected and compared with the other wheels on the vehicle. In the case of a vehicle that is also equipped with an anti-lock brake system (ABS), this comparison can be made with all of the wheels on the vehicle. To remedy a wheel spinning condition, the traction control system may reduce engine torque through a control link to the engine controller. In addition, such systems typically also activate the service brake of the spinning wheel, gently pumping the brake to slow the spinning wheel speed. This brake application to the spinning wheel allows the drive differential to transmit higher torque to other drive wheels. Such traction control systems are found in passenger cars having hydraulic braking systems as well as heavy duty trucks employing air brake systems.

Brief Summary Text (4):
In some driving conditions a traction control system can be operating for considerable period of time. For example, in the case of a heavy duty truck climbing a long grade in low traction conditions, a traction control system may activate a service brake on a driving wheel over repeated cycles. However, service braking systems have inherent energy dissipation limits. Accordingly, in such conditions, brake friction material temperatures, and rotor or drum temperatures can reach extreme levels. Since braking torque decreases in such conditions, a condition referred to as brake "fade" occurs and thus continued traction control

performance decreases. More importantly however, since time is necessary for the brake parts to cool, braking performance could be degraded and excessive friction material wear occurs. In air brake systems, brake application uses high pressure air stored in a reservoir which becomes depleted through repeated brake application over a short duration. In view of this, it may further be desirable to disable traction control to preserve braking air pressure.

Brief Summary Text (5):
As one means of avoiding the above referenced condition, brake component temperature measurements could be taken. A thermocouple or other temperature sensor can be embedded within a brake lining or other brake part. Through the use of an associated controller, excessively high brake temperatures can be monitored and could also be used to disable a traction control system to preclude brake fade conditions. Alternatively, direct brake pressure measurements could be taken and used to disable traction control in some conditions. Although such systems are believed operable, they would require a significant addition of hardware to a vehicle and would complicate assembly and servicing. In addition, maintenance and reliability problems could be presented.

Brief Summary Text (6):
In view of the foregoing, there is a need for an improved traction control system and method of operating such a system which would reduce the likelihood of adverse brake conditions occurring through operation of traction control.

Brief Summary Text (7):
Since traction control systems require wheel speed inputs and active brake controllers, they are almost universally provided on vehicles also having ABS. In fact, in many cases traction control is provided as an enhancement to an ABS with little or no additional hardware. Through appropriate control algorithms and software, an ABS controller can be operated to provide traction control.

Brief Summary Text (8):
In accordance with the present invention, the development of adverse brake conditions due to traction control operation is prevented through a system and control method which monitors the activity of the traction control system and using assumptions about brake system characteristics, disables the traction control system in some operating conditions.

Drawing Description Text (2):
FIG. 1 is a schematic diagram of a heavy-duty truck air braking system incorporating ABS and traction control and incorporating the features of the present invention;

Drawing Description Text (3):
FIG. 2 is a graph showing brake temperature, and low and high traction wheel speed verses time for a vehicle undergoing unconstrained traction control operation;

Drawing Description Text (4):
FIG. 3 is a graph showing air brake system reservoir pressure as well as brake chamber pressure for a spinning wheel under unconstrained traction control operation and corresponds with the system behavior shown in FIG. 2;

Drawing Description Text (5):
FIGS. 4 and 5 are logic flow charts of two embodiments of the traction control system and method of the present invention.

Detailed Description Text (3):
FIG. 1 shows various components connected by solid lines which designate electrical connections, whereas parallel lines show air flow conduits. As also shown in FIG. 1, system 10 includes front axle wheels 12 which are steered and rear axle wheels

14 which are driven to provide traction. Since system 10 is an air brake system, front axle brake actuators 16 are provided which are linked to brake shoes when drum type brakes are used, or a caliper for a disc brake to exert braking action on the associated wheels. Similarly, rear axle brake actuators 18 are also provided to exert braking action. Rear brake actuators 18 also incorporate an internal spring which engages the brake when air pressure is not applied to the system, thus providing a parking and emergency brake feature. In order to move the vehicle, air pressure must be applied to actuators 18 to overcome the force exerted by the internal springs in order to release the braking system.

Detailed Description Text (4):
ABS and traction control systems require wheel speed input signals which are provided through the use of an exciter or tone ring 20 which rotates with each of the wheels. Wheel speed sensors 22 mounted to the vehicle chassis are positioned adjacent exciter rings 20 and provide an output in the form of an AC signal which varies in voltage and frequency as the speed of the wheel increases or decreases. Variable reluctance transducers are frequently employed for this application in which the flux density in the gap between exciter 20 and wheel speed sensor 22 varies as the exciter teeth move across a pole piece of the wheel speed sensor.

Detailed Description Text (6):
The brake control system 10 includes an air pressure accumulator tank 32 which serves as a high pressure reservoir. Service brake valve 34 is actuated by the vehicle operator to manually activate the service brakes. Separate front and rear axle brake systems are provided. The front brake system including quick release valve 36 which receives air pressure signals for the front axle and through front axle brake modulators 28, sends air pressure signals to front axle brake actuators 16. In a similar manner, air pressure signals are sent to rear axle brake actuators 18 through traction valve 38 and modulator 30. Electronic control unit 24 is conveniently mounted directly to traction valve 38, but could be mounted elsewhere if desired.

Detailed Description Text (7):
As further shown in FIG. 1, ABS warning light 39 is provided to warn the operator of a failed system. Retarder drive output 40 disables a dynamic braking system in conditions where its operation could result in wheel lock-up. Traction indicator 41 notifies the operator that the system is operative.

Detailed Description Text (9):
As discussed previously, traction control features of system 10 use differential braking action across the driven axle to enhance a vehicle's traction capabilities. Situations can arise where due to either incipient brake fade, or system pressure or friction limitations, system 10 is no longer effective in transferring driving torque from the low traction wheel to the high traction wheel. Allowing continued operation of the traction control system when either pressure or friction limits have been reached can result in significant brake lining wear. This condition is diagrammatically illustrated in FIGS. 2 and 3. With time on the horizontal axis, various parameters are depicted in FIGS. 2 and 3. Time in both figures is plotted over a period from the beginning of a traction control operation sequence to the point where adverse braking system conditions are encountered. As shown by curve 42 in FIG. 2, brake temperature increases gradually until a critical condition is reached at which a significant rise in brake temperature is exhibited. This high temperature condition can result in significant brake lining wear and brake fade conditions. Also plotted on FIG. 2 are curves showing wheel speeds of wheels on a driving axle in which one wheel encounters low friction coefficient conditions while the other maintains tractive engagement with the road. Curve 44 depicts the high traction wheel speed which is shown gradually increasing over time but does not encounter spinning conditions. However, on the opposite side of the vehicle, a low traction wheel speed depicted by curve 46 encounters a low coefficient of friction condition or other condition which leads to wheel spinning. The cyclical

variation in low traction wheel speed occurs through the operation of the traction control features of brake control system 10.

Detailed Description Text (10):
In FIG. 3, brake chamber air pressure is plotted in which the brake is cyclically "pumped" on curve 48 against time for the spinning wheel. FIG. 4 shows additional system parameters corresponding to the behavior shown in FIG. 3 and the time axis for FIG. 3 corresponds directly to FIG. 2. Brake chamber air pressure as plotted is the pressure signal passing through the brake modulator 30 which activates the service brake. In a typical traction control operation sequence, a given pressure build command will result in a pressure increase with subsequent build commands further increasing the pressure applied to the brake of a low traction wheel. This action is designated by the saw-tooth pressure build command shown in FIG. 3. The step-wise increase in pressure occurs due to the fact that electronic control unit 24 including an internal clock and the system is controlled in a digital manner based on the clock rate. The step-wise increases in pressure occurs until the system detects wheel speed decreasing producing a ramp-down exhaust command. The result is the cyclically varying low traction wheel speed shown by curve 46.

Detailed Description Text (11):
When either brake fade or pressure limitations are encountered the sequence of pressure build commands without an exhaust command will appear as shown in FIG. 3 after t.sub.1. As is shown after t.sub.1 there is an increased time over which the chamber pressure builds, followed by an exhaust command. Since system 10 is having greater difficulty in slowing the spinning wheel which may occur due to high brake temperatures. Other factors may lead to the inability of the system to provide the desired braking effect traction control. For example, the brake system pressure available from accumulator 32 depicted by curve 50 may be reduced through repeated activation of the spinning wheel brake actuator. In some conditions reservoir pressure can reach a point where adverse braking conditions exist.

Detailed Description Text (13):
In accordance with the present invention, when the number of consecutive build commands from control unit 24 (i.e. ramp-up steps of brake chamber pressure) or the time before an exhaust command exceeds a predetermined number or time, the traction control features of system 10 will cease to operate. In such conditions, the system will remain inoperative for a predetermined time period to allow either the brake components to cool or the system pressure to recover, afterwhich normal traction control system operation will be restored.

Detailed Description Text (14):
Two modes of operation of brake control system 10 where suggested above. One mode is based on counting pulses of a pressure build sequence, and the other is based on measuring time of such a sequence. The operational modes of electronic control unit 24 are shown in FIGS. 4 and 5. These figures provide a logic flow chart or routine of operation of brake control system 10 hardware and software. Block 54 provides a clock pulse input to the system designated as "TCKME". For example, a 30 millisecond timing clock pulse can be used. Block 56 resolves whether or not traction control is disabled. If not disabled, it is determined if brake chamber pressure is building on a traction wheel at block 58. If no pressure is building, the exit block 67 is reached and the routine is repeated through block 56. If chamber pressure is building on a traction wheel, block 60 inquires if the number of consecutive build commands is greater than the predetermined "maximum number of build pulses" designated as "NBLDMX" for the system which is allowed for a traction wheel. If this number has not been exceeded, exit 67 is reached and the routine is repeated. If the number of build pulses has exceeded the parameter, for example 200 pulses, traction control operation is disabled at block 62. Since for each clock pulse the routine is repeated, when traction control is disabled the software considers at block 64 if the elapsed time of traction control being disabled, designated "TDIS" exceeds a threshold, for example 7 seconds. If it has not, then

the routine is repeated leaving the system disabled. If the threshold time has been exceeded, traction control is enabled at block 66. Thus, the system operates merely by counting the number of consecutive build pulses from electronic control unit 24, and since this can be provided by software modifications to an existing traction control system, this feature can be provided at a very low cost without the need to directly sense brake temperature or brake system pressure.

CLAIMS:

1. A brake control system for a motor vehicle having traction control coupled to service brakes of driven wheels of the motor vehicle providing differential braking action by actuating the service brake of a spinning wheel to reduce the wheel speed of the spinning wheel thereby transferring additional torque to other of the driven wheels, comprising:

wheel speed sensors for detecting the rotational speed of said driven wheels and for generating a wheel speed signal for each of said driven wheels,

brake modulator means for each of said driven wheels for receiving a brake actuation signal and actuating said service brake associated with each of said brake modulator means, and

a control unit for receiving said wheel speed signals for each of said driven wheels and generating said brake actuation signal in response to a wheel spinning condition, said brake actuation signal for a spinning wheel being generated for not more than a predetermined actuation signal time period, said control unit limiting the duration of said predetermined actuation signal time period to avoid conditions which could cause adverse service brake conditions.

5. A method of operating a brake control system for a motor vehicle having traction control of the type coupled to service brakes of driven wheels of the motor vehicle providing differential braking action by actuating the service brake of a spinning wheel to reduce the wheel speed of the spinning wheel thereby transferring additional torque to other of the driven wheels, comprising the steps of:

detecting the rotational speed of said driven wheels and generating a wheel speed signal for each of said driven wheels,

providing a brake modulator means for each of said driven wheels for receiving a brake actuation signal and actuating said service brake associated with said brake modulator means,

providing a controller means for receiving said wheel speed signals for each of said driven wheels and generating said brake actuation signal in response to a wheel spinning condition, said brake actuation signal for a spinning wheel being generated for not more than a predetermined actuation signal time period, and

limiting the duration of said predetermined actuation signal time period to a predetermined period of time calculated to avoid conditions which could cause adverse service brake conditions.

7. A method of operating a traction control system according to claim 5, further comprising the step of:

generating clock pulses at regular intervals and limiting the duration of said predetermined actuation signal time period by limiting said duration to a predetermined number of said clock pulses.

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